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POWERTRAIN TROUBLESHOOTING

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MEC-161 EXAM PREVIEW

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Exam Preview:

1. Power takeoffs are attachments in the power train for power to drive auxiliary accessories. They are attached to the transmission, auxiliary transmission, or transfer case. A common type of power takeoff is the multi-gear, multi-speed type.
    a. True
    b. False
2. Some whining or grinding noise can be expected, especially when the vehicle is being driven in first or reverse gear. The first-and-reverse sliding gear together with its mating countershaft gear and reverse idler gear are _____ gears.
    a. Worm
    b. Helical
    c. Spur
    d. Bevel
3. According to the reference material, a humming noise in the differential generally means the ring gear or pinion needs an adjustment.
    a. True
    b. False
4. Because of the variations in construction of transmissions, different procedures in the removal, disassembly, repair, assembly, and installation must be followed. These operations generally require from ____ hours, depending on the procedure followed.
    a. 3 to 5
    b. 5 to 7
    c. 8 to 10
    d. 10 to 12

5. According to the reference material, there are three types of live axles used in automotive and construction equipment: semi floating, three-quarter floating, and full-floating. Which of the following matches the definition: used on most passenger cars and light trucks and has its differential case independently supported?
    a. Semi floating
    b. Three-quarter floating
    c. Full-floating
    d. N/A
6. Using Table 11-2. —Transfer Case Troubleshooting Chart, which of the following malfunctions has a probable cause of a defective gear synchronizer?
    a. Transfer case slips out of gear
    b. Front wheels do not drive when rear wheels lose traction
    c. Transfer case will not shift
    d. Front wheels do not drive in reverse
7. According to the reference material, when a vehicle turns a corner, one wheel must turn faster than the other. The side gear driving the outside wheel will run slower than the side gear connected to the axle shaft of the inside wheel.
    a. True
    b. False
8. Using Table 11.3—troubleshooting the Power Takeoff, which of the following probable causes does NOT indicate a noisy power takeoff?
    a. Worn bearings
    b. Stripped gears
    c. Worn shaft splines
    d. Gears partially engaged
9. A 6 x 4 truck, although having dual wheels in the rear, is identified by six wheels, four of them driving. Actually, the truck has __ wheels but the four wheels attached to the driving wheels could be removed without changing the identity of the truck.
    a. 6
    b. 8
    c. 10
    d. 12
10. Noises that may originate in the transmission are difficult to describe. A noise that may sound like a howl to you may sound like a squeal to someone else. Other terms often used to describe gear or bearing noises may include such words as “hum,” “knock,” “grind,” “whine,” and “thump.”
    a. True
    b. False

TROUBLESHOOTING TRANSMISSIONS, TRANSFER CASES, AND DIFFERENTIALS

It does not matter how well your engine is running, how good the road conditions are, or how proficient an operator you may be. If the power of the engine of the vehicle you are operating cannot be transmitted to the wheels, the vehicle may as well be on the deadline. It is the function of the transmission to match the vehicle load requirements to the power and speed of the engine. The transfer case is used for the same function and, in addition, allows for the coupling and uncoupling of the front-wheel drive components. The differential is used to change the rotational axis of engine torque 90 degrees from the propeller shaft to the front and rear axles. Another purpose of the differential is to divide engine torque between the driving wheels so that they are free to rotate simultaneously at varying speeds.

This chapter provides information on standard transmissions, transfer cases, differentials, and the various indications of abnormal operation so that you will be able to diagnose the problems with these units and prescribe corrective action. To obtain more detailed information on the operation and repair of these units, refer to the specific manufacturer's manuals. Figure 11-1 shows the location of each of the components discussed in this chapter.

THE STANDARD TRANSMISSION

The operation of standard transmissions on automotive vehicles is described in *Construction Mechanic 3 and 2,* NAVEDTRA 10644-G1. You should review chapter 8 of the training course before studying the material in this section.

Generally, you will not be doing troubleshooting or repair work yourself. Since you will supervise such operations, however, it is essential that you know the proper procedures for performing these duties and for solving particular maintenance problems.

All transmissions are designed to perform the same functions. In construction and application, of course, transmissions vary considerably. One example is shown

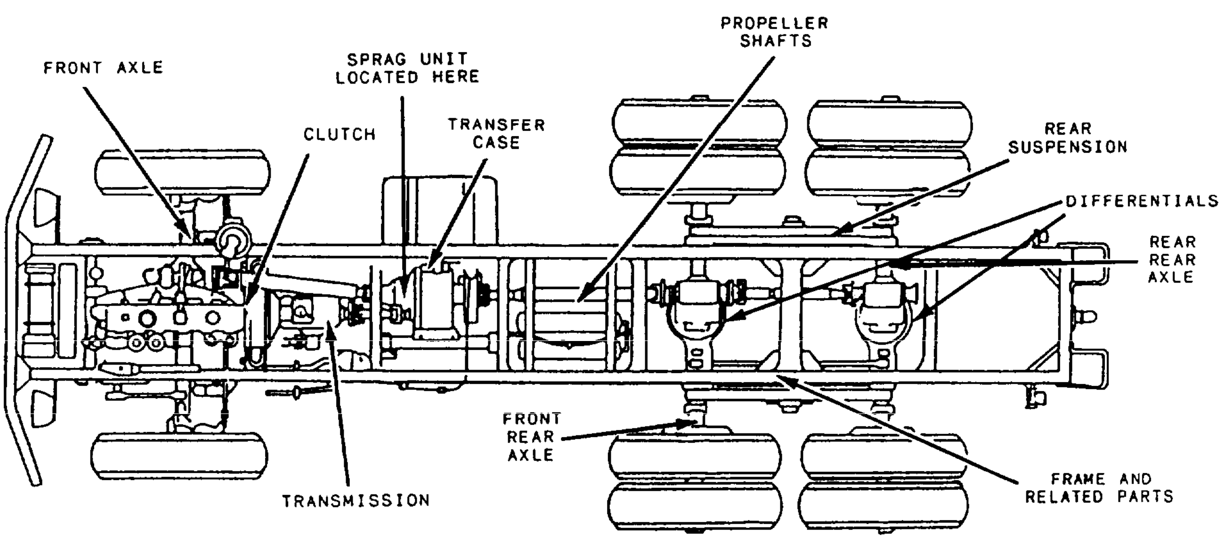


Figure 11-1.—Location of power train components in a military 5-ton vehicle.

in figure 11-2. Consequently, it is not possible to discuss all makes and models that you may encounter in the Navy. The information contained in this section is general; for problems and procedures on any particular transmission, consult the manufacturer's manual.

It is seldom that the transmission of a vehicle is manufactured by the same company that manufactured the vehicle. Some manufacturer who specialized in building automotive parts generally makes the transmission and sells it to the vehicle manager. A nameplate attached to the side of the transmission case will have the manufacturer's name and the model number of the transmission. The Spicer Company, for instance, uses a four digit number for a model number, such as 8051. The third digit of the number indicates the number of forward speeds available in that particular transmission. Therefore, the model 8051 is a five-speed transmission.

If a transmission does not have a nameplate, refer to the vehicle manufacturer's manual for identification.

TROUBLESHOOTING TRANSMISSIONS

It is important that transmissions troubleshooting be done by trained, experienced mechanics. Many times an operator will report transmission noise on the Operator's Trouble Report, when, in fact, the noise maybe coming from some other component of the power train of the vehicle.

Noises that appear to come from the transmission but actually originate at some other point are many and varied; for example, unbalanced propeller shaft, defective wheel bearings, or damaged tires on a vehicle may cause noises that are transmitted to the transmission. These noises have no particular or characteristic sounds that would indicate their origin; therefore, they are difficult to identify.

Torsional vibration is one of the most frequent causes of noises that appears to be in the transmission, but actually originates outside of it. Included among these possible outside torsional vibrations are the following:

1. Propeller shaft (drive shaft) out of balance
2. Worn universal joints
3. Drive shaft center bearings loose
4. Worn and pitted teeth on axle pinion and ring gear
5. Wheels out of balance

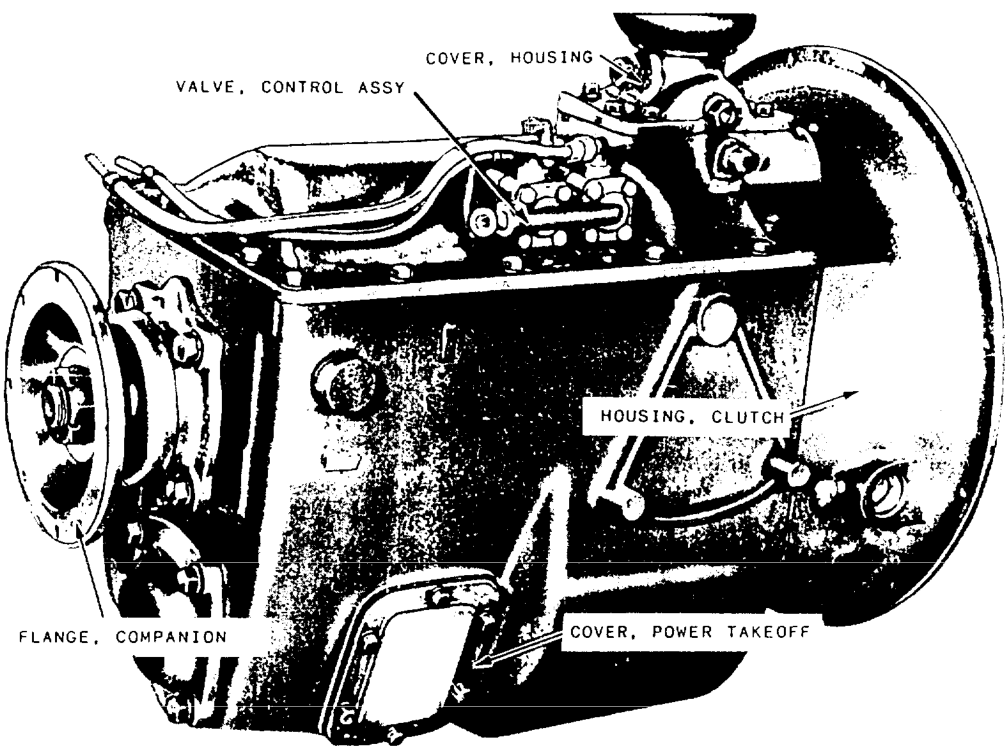


Figure 11-2.—Typical example of a heavy-duty truck transmission.

6. Worn spring pivot bearings
7. Loose frame or axle U-bolts
8. Engine cooling fan out of balance
9. Engine crankshaft, flywheel, and/or clutch plate out of balance
10. Tires or wheels wobbly or mismatched

This list, along with other troubles you have encountered in your own experience, can be used as a step-by-step guide in transmission noise troubleshooting. Make sure that all possibility of outside noise has been eliminated before you have your personnel remove the transmission.

When analyzing a vehicle for transmission noise, raise the vehicle so that the driving wheels are clear of the deck. Start and operate the vehicle in all the speed ranges, including COASTING with the shift lever in neutral. Listen carefully for noises and try to determine the origin. There are other procedures for checking transmission noises that may be used. Principally, any procedure used relies on the experience and good judgment of the mechanic doing the troubleshooting.

When it is determined that the noise is with the transmission, generally it is necessary for the transmission to be removed from the vehicle and disassembled.

Remember, however, you should never be satisfied with just finding and correcting the trouble. You should always try to find what caused the trouble. If you find a transmission with broken gear teeth, do not be satisfied with just replacing the transmission. Try to find out what caused the transmission to malfunction.

Whenever you find such components as the transmission in an unserviceable condition, talk to the driver. The driver may be able to explain exactly how the failure occurred and give you a clue as to the cause of the failure.

If you fail to find the cause, you will probably have to do the job over because the same trouble will most likely develop in the replacement transmission. Table 11-1 is a basic troubleshooting chart. As

Table 11-1.—Troubleshooting Transmissions (5-ton military)

Troubleshooting Transmissions (5-ton military)		
Malfunction	Probable Causes	Corrective Action
1. Transmission slips out of gear.	a. Shifter forks loose on shifter shafts.	a. Remove shifter housing and tighten shifter forks setscrews (fig. 11-3) and replace locking wires.
	b. Shifter shaft detent grooves worn.	b. Remove shifter housing (fig. 11-4) and install new shifter shafts.
	c. Gear teeth worn.	c. Disassemble transmission and replace worn gears (fig. 11-5).
	d. Excessive end play in main drive shaft.	d. Tighten main shaft companion flange nut.
2. Transmission operates satisfactorily in reverse and first, but will not shift to second or third.	Defective second and third speed gear synchronizer.	Disassemble transmission and replace gear synchronizer (fig. 11-6).
3. Transmission operates satisfactorily in reverse, first, second, and third, but will not shift into fourth or fifth.	Defective fourth and fifth speed synchronizer assembly.	Disassemble transmission and replace synchronizer assembly (fig. 11-7).

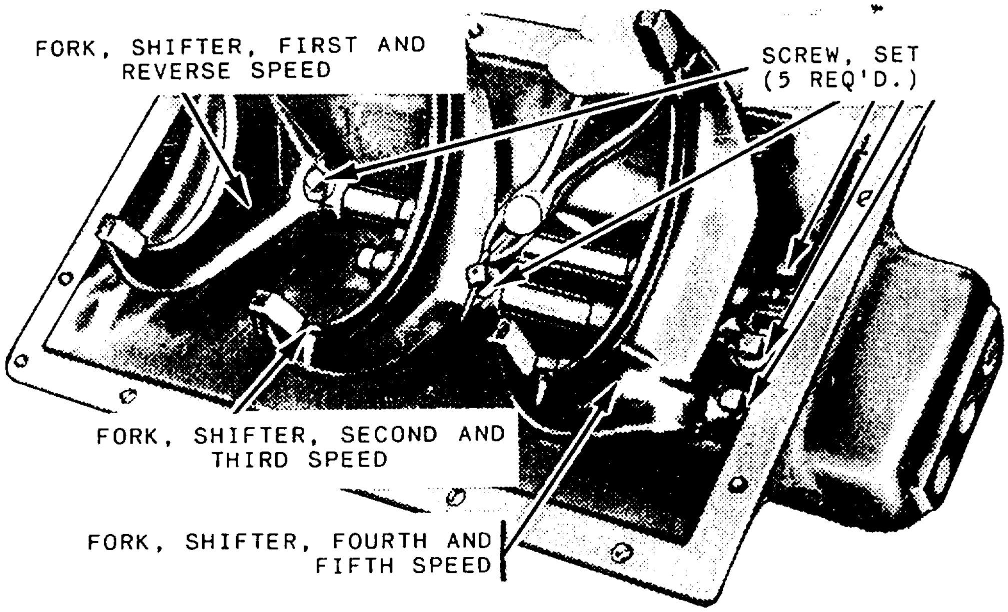


Figure 11-3.—Location of shifter fork setscrews.

referenced in the chart, you should refer to figures 11-3, 11-4, 11-5, 11-6, and 11-7 respectively.

Inspecting the Transmission

Leaking oil seals and gaskets are probably the most common causes of transmission problems. If such problems are not corrected in time, the gears, shafts, and bearings can be ruined.

There are many possible causes for oil seal or gasket failures, so always look for causes whenever you find such failures, and certainly before the unit is placed back in operation.

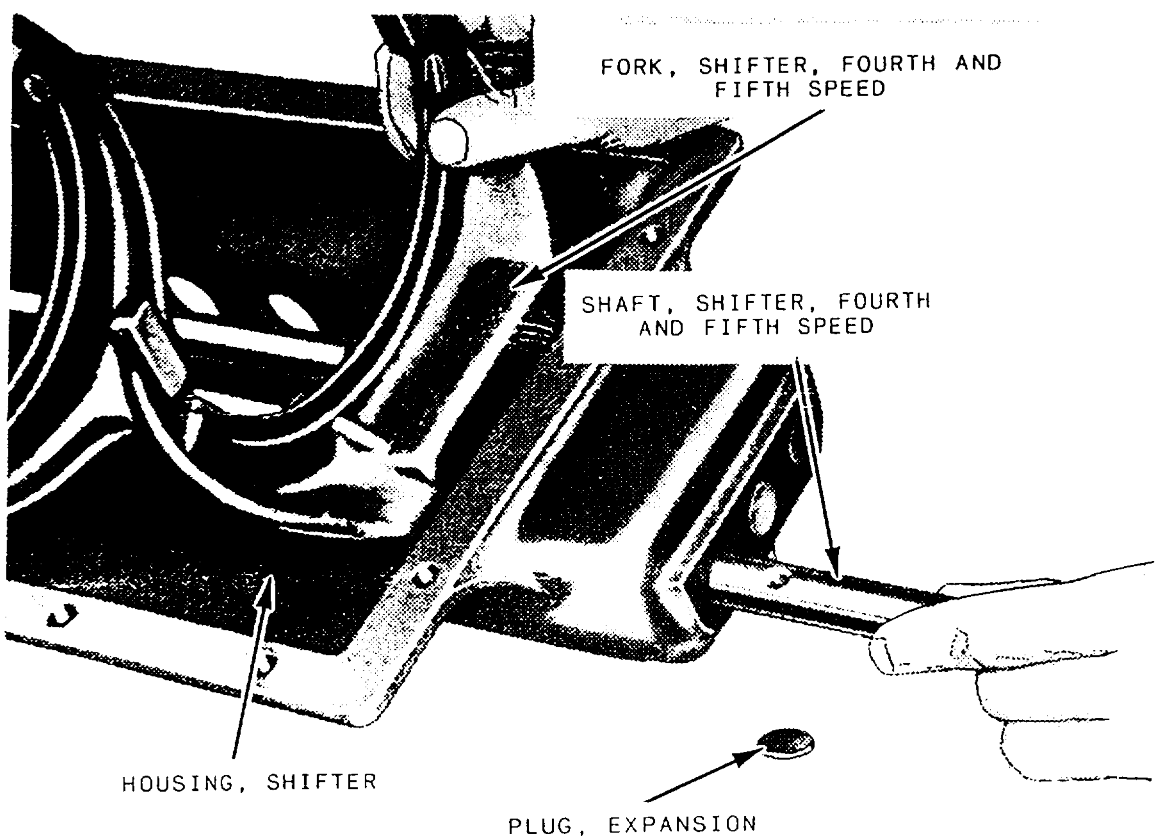
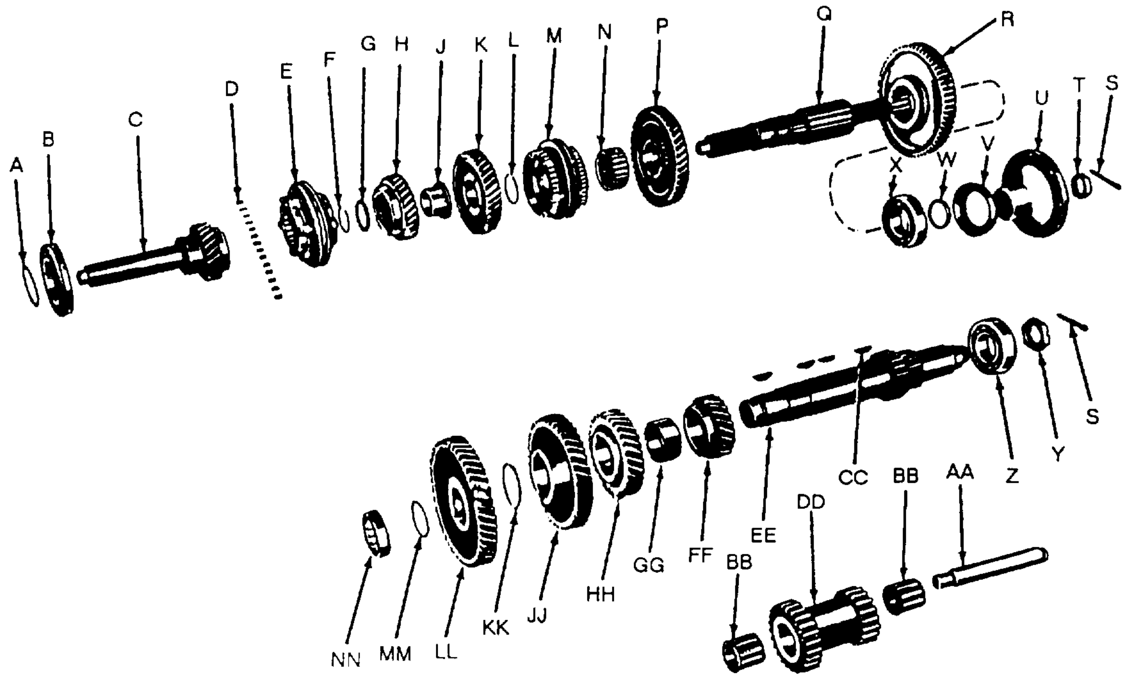


Figure 11-4.—Replacing shifter shafts and forks.



- **A.** Ring, snap, bearing
- **B.** Bearing, ball, input shaft
- **C.** Shaft, input
- **D.** Roller, pilot, bearing
- **E.** Synchronizer, fourth and fifth speed gear
- **F.** Ring, snap, fourth speed gear
- **G.** Washer, thrust
- **H.** Gear, fourth speed
- **J.** Sleeve, fourth speed gear
- **K.** Gear, third speed
- **L.** Ring, snap, second and third speed clutch gear
- **M.** Synchronizer, second and third speed gear
- **N.** Gear, second and third speed clutch
- **P.** Gear, second speed
- **Q.** Shaft, main
- **R.** Gear, first and reverse speed
- **S.** Pin, cotter
- **T.** Nut, slotted
- **U.** Flange, companion
- **V.** Slinger, dust
- **W.** Washer, spacing, rear bearing
- **X.** Bearing, ball, main shaft, rear nut, slotted
- **Z.** Bearing, ball, countershaft, rear
- **AA.** Shaft, reverse idler gear
- **BB.** Bearing, roller, reverse idler gear
- **CC.** Key, Woodruff
- **DD.** Gears, reverse, idler
- **EE.** Countershaft
- **FF.** Gear, second speed, countershaft
- **GG.** Spacer, countershaft
- **HH.** Gear, third speed, countershaft
- **JJ.** Gear, fourth speed, countershaft
- **KK.** Ring, snap, fourth speed gear, countershaft
- **LL.** Gear, drive, countershaft
- **MM.** Ring, snap, drive gear, countershaft
- **NN.** Bearing, roller, countershaft, front

Figure 11-5.—Transmission gears and shafts-exploded view.

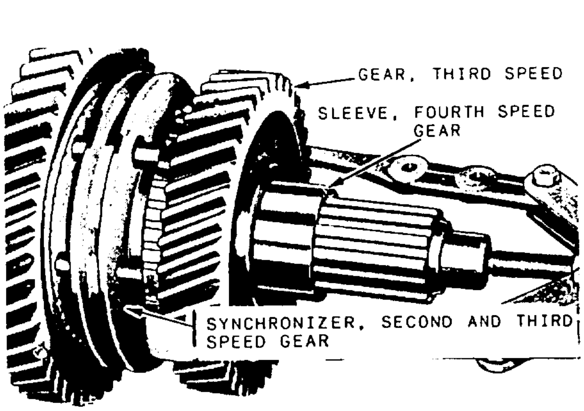


Figure 11-6.—Disassembling fourth speed gear sleeve.

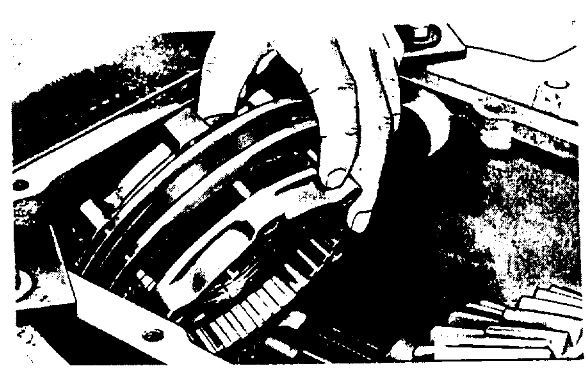


Figure 11-7.—Removing the fourth and fifth speed gear synchronizer from main shaft.

Cause of Leaking Lubricants

Now let us review some of the reasons why the lubricant is likely to leak at any one or several of these locations. First of all, a transmission (or almost any other gear case) will usually start leaking if the oil level is too high. To stiffen the oil used in gear cases, some manufacturers use soap and soda in the oil. As the gears operate, the oil is splashed all over the inside of the gear case. Because of the soap and partly because of the splashing and the heat, the oil starts to foam or fill with air bubbles. Thus the oil expands and takes up more room. This action creates excessive pressure inside the gear case. If the oil level is too high to start with, the pressure created inside the transmission many be more than the seals and gaskets can resist and the oil will start leaking out. Leaking can occur at any one or several locations.

The transmission oil level should only be checked after the vehicle has been parked for several hours or overnight. During this time, the bubbles or foam will cool and settle as a liquid in the bottom of the transmission case.

- With the transmission cold, remove the fill plug. The oil level should be at, or just below, the bottom of the till plughole.
- If the oil level is too high, allow the excess oil to run out the fill plughole.

Even if the oil level is correct, it is possible that the foaming action of the oil will cause the pressure inside the transmission to become too high. To permit the excess pressure to escape, a vent valve is used. This valve contains a seat and spring-loaded ball, and has a dust cap over the valve assembly.

To check the vent valve, first make sure the area around it is free of dust and dirt.

- Then try turning the dust cap with your fingers. It should turn freely in either direction. If it does not turn freely, replace it.

Gaskets or oil seals will always leak if the bolts securing the plates, covers, or retainers are loose. All of the bolts should be tightened uniformly with a torque wrench.

The bolts that secure the input shaft retainer, the gearshift housing cover, and the retainer seals should be tightened with a torque wrench to the manufacturer's specifications. If tightening the bolts fails to stop the leak at this point, the transmission should be disassembled and the source of the leak repaired.

Leaks around the threads of the fill plug, the drain plugs, or any of the bolts can usually be stopped by coating the threads of the plugs or bolts with a lead-based paint.

A loose gearshift retainer will also allow the lubricant to escape.

All of the seals need to be lubricated; otherwise, they will be ruined. Therefore, a little seepage around any seal is normal. A seal is not considered as leaking unless enough oil is escaping by the seal to drip on the ground and cause a small puddle.

Leaking Seals

With the power plant in the vehicle, you can inspect all seals except the input shaft retainer seal. If this seal is leaking, oil will drip out through the plughole in the bottom of the pan under the flywheel housing when the plug is removed.

If oil does drip out at the flywheel housing drain plug, examine the oil closely. It may be engine oil leaking from the engine crankshaft rear oil seal. The engine oil is much thinner (has less viscosity) than the transmission oil, so you should be able to tell which seal is leaking.

An oil leak, either from the engine or transmission input shaft seals, is serious, because the oil can ruin the clutch. An oil-soaked clutch disk will almost always slip or grab.

TESTING TRANSMISSIONS FOR MALFUNCTIONS

In addition to the leakage problems, there are other problems that can develop in the standard transmissions used in almost all trucks. We can classify these as mechanical problems.

The best way to locate mechanical problems in the transmission is to road test the vehicle. Before road testing, however, check for missing or loose bolts and be sure the oil is at the proper level in the transmission case. Check the parking brake mechanism for proper mounting and correct adjustment. Check all moisture seals or boots. Check the action of the gearshift levers.

The transmission is often blamed for problems that are elsewhere. For example, with the engine running and the vehicle standing still, disengage the clutch and move the gearshift lever into first or reverse. You should be able to shift into either of these gear positions without any gear clashing or without the vehicle moving. If the gears clash or the vehicle attempts to move with the clutch disengaged, the trouble is in the clutch and not the transmission.

Check the clutch pedal free travel and adjust it if necessary. The clutch must be correctly adjusted before the transmission can operate properly. The clutch must fully disengage every time the clutch pedal is pushed all the way down, and it must fully engage every time the pedal is released.

With the transmission in neutral, the engine running, and the clutch engaged, all of the constant-mesh gears in the transmission will be turning. There should be very little gear or bearing noise.

If the transmission is quiet in neutral with the clutch engaged, disengage the clutch. If a noise is now heard, the trouble is with the clutch and not the transmission. Usually, the clutch release bearing or the clutch shaft pilot bearing is at fault if a noise is heard only when the clutch is disengaged.

Sometimes, noises in other parts of the power train, such as U-points, propeller shafts, and differential, sound as if they are in the transmission. The misalignment of power train components usually produces a noise that may sound as if it is coming from the transmission. So be sure to check all mounting bolts on the engine, transmission, and differentials before road testing the vehicle. Also, check the propeller shafts and U-joints for evidence of wear or looseness.

Loose, bent, or shifted suspension system components will cause misalignment of the power train components that can produce a noise that may sound like a defective transmission.

Noises that may originate in the transmission are difficult to describe. A noise that may sound like a howl to you may sound like a squeal to someone else. Other terms often used to describe gear or bearing noises may include such words as “hum,” “knock,” “grind,” “whine,” and “thump.”

If a teeth is broken off of one of the gears, a distinct thumping noise will be heard once during a complete revolution of the gear. The thump will be more pronounced if torque is being delivered through that gear.

Gears with worn, rough teeth will usually produce a grinding noise, especially when torque is being transmitted through them.

Bearing noise is usually described as a howl, whine, or squeal. Actually, the type of noise made by a defective bearing will vary, depending on the type of defect and the load the bearing is supporting. In any event, loud noises coming from inside the transmission mean trouble.

Some whining or grinding noise can be expected, especially when the vehicle is being driven in first or reverse gear. The first-and-reverse sliding gear together with its mating countershaft gear and reverse idler gear are spur gears, Spur gears are always noisy, but, as you recall from a preceding lesson, they are frequently used because they are cheaper and do not produce thrust.

In the second-, third-, and fourth-speed ranges, the transmission should be much quieter than in first or reverse.

If, after a road test, you think the transmission is too noisy, be sure and report it to the maintenance supervisor. Be sure to describe the conditions under which the noise occurs.

Another common mechanical problem with transmissions of this type is slipping or jumping out of gear. Actually, the transmission is much less likely to slip or jump out of first or reverse than out of second-, third-, or fourth-speed gear. Second-, third-, and fourth-speed gears are all helical gears which, you recall, produce thrust.

The most likely causes of the transmission slipping out of gear are worn detent balls or springs in the shifter shaft cover. These spring-loaded balls hold the shifter shaft in position. If the spring does not have enough tension or if the balls are worn, the transmission will almost certainly slip or jump out of gear. Synchronizer damage will also cause the transmission to jump out of gear.

Slipping out of any gear is most likely to occur when the driver suddenly takes his or her foot off the accelerator pedal, especially when descending a steep hill. The thrust produced by the helical gears will tend to move all rotating gears and shafts to the rear of the transmission, as long as the torque provided by the engine is being delivered to the rear wheels by the transmission. However, when the driver takes his or her foot off of the accelerator pedal, the situation is changed. The rear wheels now try to drive the engine through the transmission. This reverses the direction of the torque being delivered through the transmission gears, and the thrust is now toward the front of the transmission. If this thrust is not controlled by the thrust washers and bearing retainers, it is likely to force the shifter shaft to move in spite of the spring-loaded ball that holds it. When this happens, the transmission slips out of gear.

Occasionally, a transmission slips out of gear because the driver does not fully engage the gear when moving the lever. However, when a transmission slips out of gear fairly often, it should be replaced.

OVERHAUL OF THE TRANSMISSION

Because of the variations in construction of transmissions, different procedures in the removal, disassembly, repair, assembly, and installation must be followed. These operations generally require from 5 to 7 hours, depending on the procedure followed. If you are working on a vehicle with which you are not familiar, always check the manufacturer's manual.

Before removing the transmission from the vehicle, make sure all accumulations of dirt or road mud are cleaned from the case and the attached parts. Note or mark by scratching the case with a sharp pointed tool, any moist oil spots or unusually heavy accumulations of oil-soaked road mud; these we good clues to the location of small cracks or holes that might escape notice in visual inspection. However, do not confuse these accumulations with those that result from leaking gaskets or oil seals. A leak at a gasket or a seal is more or less normal on a transmission that has been in service for any length of time.

Drain the lubricant from the transmission. Some manufacturers recommend flushing the transmission before removal. This is done by filling the transmission with a flushing oil and operating the engine with the transmission in neutral for several seconds. After this, drain the flushing oil from the transmission.

After removing the transmission case, complete the external cleaning operation with steam-cleaning equipment or by hand brushing the case, using an approved cleaning solvent.

After the transmission is disassembled, make sure all parts are cleaned thoroughly and individually.

Clean away all the parts of hardened oil, lacquer deposits, and dirt, paying particular attention to the small oil holes in the gears and to the lock ball bores in the shifter shaft housing. Remove all gaskets or parts of gaskets using a scraper or other suitable tool. Make sure the metal gasket surfaces are not gouged or scratched.

After all parts of the transmission have been thoroughly cleaned, inspect them to determine whether they can be reused or scrapped. The wear or damage to some of the parts will be evident to the eye, (fig. 11-8) whereas, in others, it may be necessary to use tools or gauges to determine their condition. Since the decision as to whether apart should be scrapped or reused is often a matter of opinion or judgment, you may want to do this job yourself. If you can not do the inspecting yourself, make sure the person doing it is experienced in transmission maintenance and overhaul.

When inspecting transmission parts, bear in mind that the inspection procedure has two objectives; first, to eliminate any part or parts that are unsuitable for use, or doubtful parts that may cause the premature failure of the overhauled transmission; second, and equally important, to reduce the wasteful practice of scrapping parts that still retain a high percentage of useful life.

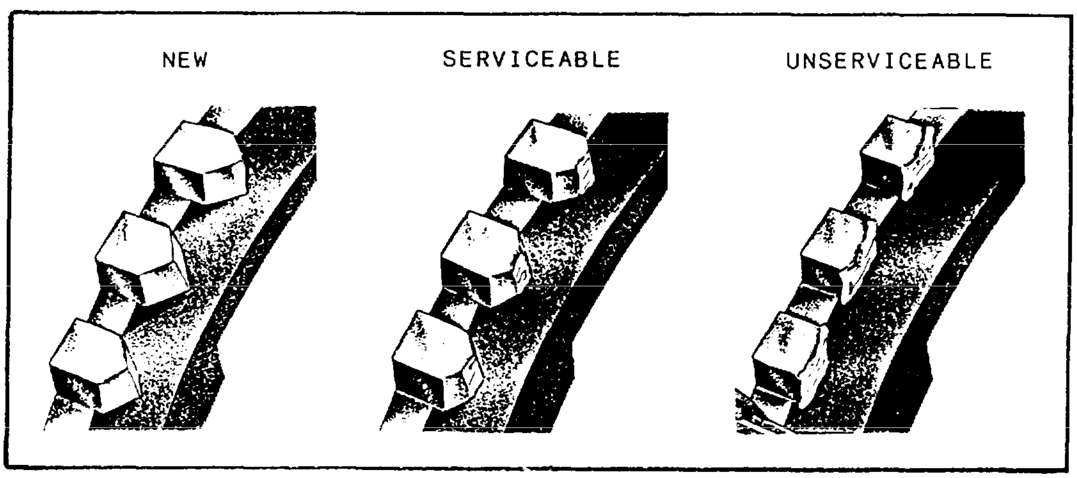


Figure 11-8.—An example of worn external teeth of a synchronizer clutch.

If a transmission part is to be repaired, make sure only good repairs are made. Makeshift or temporary repairs should not be permitted, except in an emergency. The principal purpose of repairs is to salvage components that would otherwise be scrapped. The decision as to whether apart is to be repaired rests upon three factors; First, the practicality of the repair, (That is, will the repair of the part return it to a near new condition?); second, the cost of the repair job as compared to the cost of a replacement; and third, the availability of the replacement part. If replacement parts are unavailable or in short supply, make every effort to salvage as many parts as possible.

Small holes or cracks in the transmission case, shifter shaft housing, or clutch housing maybe repaired by welding or brazing, provided they do not extend into the bearing bores or mounting surfaces. These pieces are gray (cast) iron, and special techniques are required to weld these materials satisfactorily; normally, ordinary welding methods and materials are not suitable.

To assemble a transmission, use a reverse procedure from that of disassembly. Check the manufacturer's manual for proper clearances and the wear limits of the parts.

All parts, whether new or used, should be lightly coated with lubricating oil. This is done immediately after inspection or repair. Oiling the parts gives them a necessary rust-preventative coating and facilitates the assembly operations.

Train your personnel to have all the necessary parts on hand before the assembly operation begins. This guarantees that the transmission can be completely assembled without interruptions.

As a CM1, it will be your responsibility to test the transmission after it is assembled. If all parts are correctly assembled, the transmission gears will all rotate freely without evidence of binding. Use a suitable wrench to rotate the input shaft at least ten full revolutions. Shift the transmission into all the speed ranges. If the transmission is noisy, extremely loose, or binds, it must be disassembled and further corrective measures taken.

TROUBLESHOOTING TRANSFER CASES

Transfer cases (fig. 11-9) are placed in the power trains of vehicles to allow them to operate in mud, snow, sand, and other unusual terrains. To do this, you have to have driving power available at the front wheels as well as the rear wheels so the vehicle will not get stuck. Therefore, certain wheeled vehicles include a second gearbox, called the transfer case. Its purpose is to take the output power from the transmission and divide it so

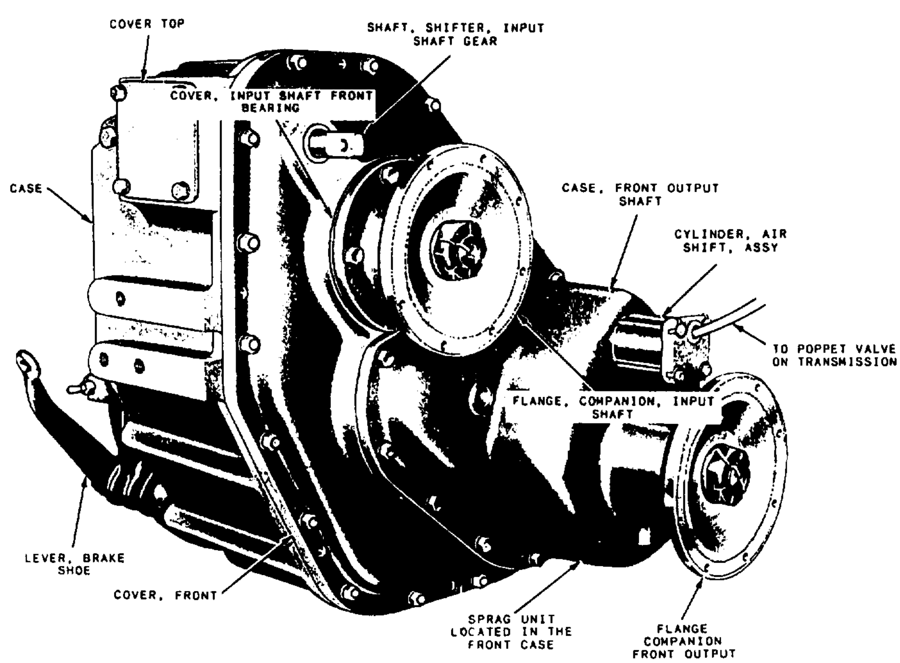


Figure 11-9.—Example of a transfer case assembly (5-ton truck, military).

that it will drive the rear wheels at all times and drive the front wheels when needed.

The transfer case can be mounted in several ways in a vehicle. It can be a separate component mounted to the rear of the transmission and driven by a propeller shaft connecting it to the output of the transmission. It can also be a part of the transmission (fig. 11-10) and driven by a gear or by the output shaft of the transmission. The transfer case performs one or more of the following functions:

- It transfers the transmission power to a point low enough so that a propeller shaft can be mounted under the engine and power the front axle.
- It provides an output to power one or more rear axles.
- It provides a high and low gear ratio for vehicles that do not have the necessary gear reductions in the transmission.
- It provides arrangements for engaging and disengaging front-wheel drive and high and low ranges when applicable.

One of the mechanic's jobs is to repair transfer cases; this means diagnosing trouble, dismantling, inspecting, and reassembling the unit. If you become familiar with the method of repairing one particular transfer case, you should not have much difficulty repairing others.

The first indication of trouble within a transfer case, as with other components of the power train, is usually "noisy" operation. If an operator reports trouble, make a visual inspection before removing the unit from the vehicle. Check for such things as oil level, oil leakage, and water in the oil.

Make sure the shift lever linkages are inspected. If the shift lever linkages are bent or improperly lubricated, it will be hard to shift the transfer case or, in some cases, will make shifting impossible. Make sure other possible troubles, such as clutch slippage, damaged propeller shaft, and damaged axles, have been eliminated.

Worn or broken gears, worn bearings, and excessive end play in the shafts will cause noisy operation of the transfer case. When it is determined that the trouble is within the transfer case, have your personnel remove the unit from the vehicle for repairs.

Make sure the transfer case is thoroughly cleaned before disassembly of the unit begins. When the unit is disassembled, have each part cleaned with an approved cleaning solvent. Inspection of the individual parts should follow the same procedure as outlined for transmissions. Avoid waste by using old parts that are in good condition. Table 11-2 is a troubleshooting chart for transfer cases. As referenced in the chart, you should refer to figures 11-11, 11-12, 11-13, and 11-14 respectively.

Personnel who are not thoroughly familiar with a particular make and model of a transfer case should be supplied with a manufacturer's repair manual. Check the job frequently to be sure the proper adjustments and assembly procedures are followed.

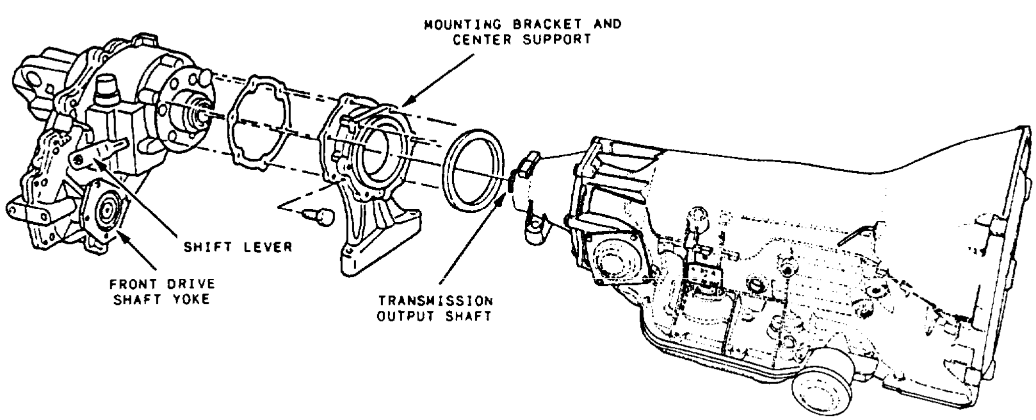


Figure 11-10.—Transfer case to the transmission.

Table 11-2.—Transfer Case Troubleshooting Chart

Transfer Case Troubleshooting Chart		
Malfunction	**Probable Causes**	**Corrective Action**
1. Transfer slips out of gear.	a. Shifter fork loose on shifter shaft.	a. Remove top cover and tighten setscrew (fig. 11-11).
	b. Shifter shaft poppet ball notches worn.	b. Disassemble transfer and install new shifter shaft (fig. 11-12).
	c. Gear teeth worn.	c. Disassemble transfer and replace worn gears.
2. Transfer will not shift.	Defective gear synchronizer.	Disassemble transfer and replace gear synchronizer (fig. 11-13).
3. Front wheels do not drive when rear wheels lose traction.	Defective sprag units. Defective front axle engagement system.	Remove transfer front output shaft case assembly and replace sprag units and other excessively worn parts.
4. Front wheels do not drive in reverse.	Defect sprag units.	Troubleshoot front axle engagement system (fig. 11-14) and replace as required.

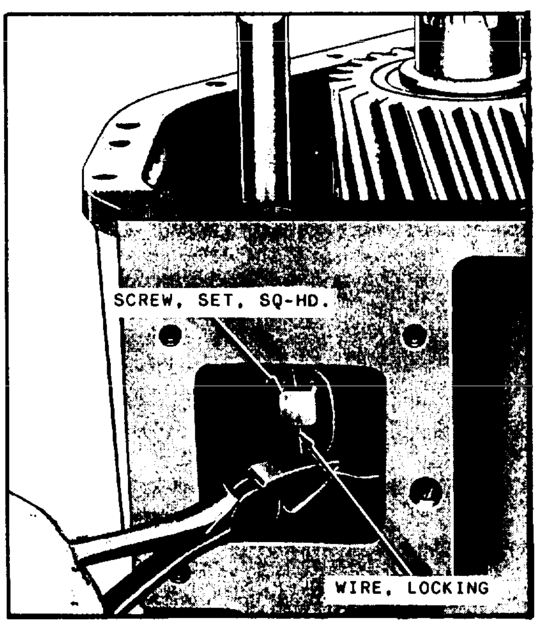
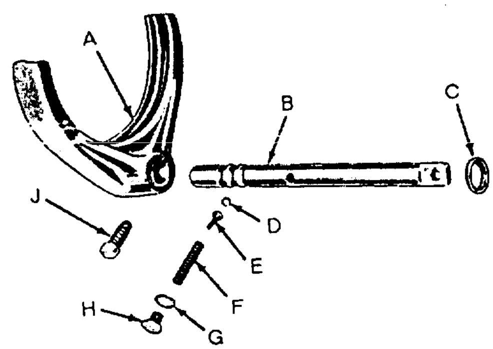
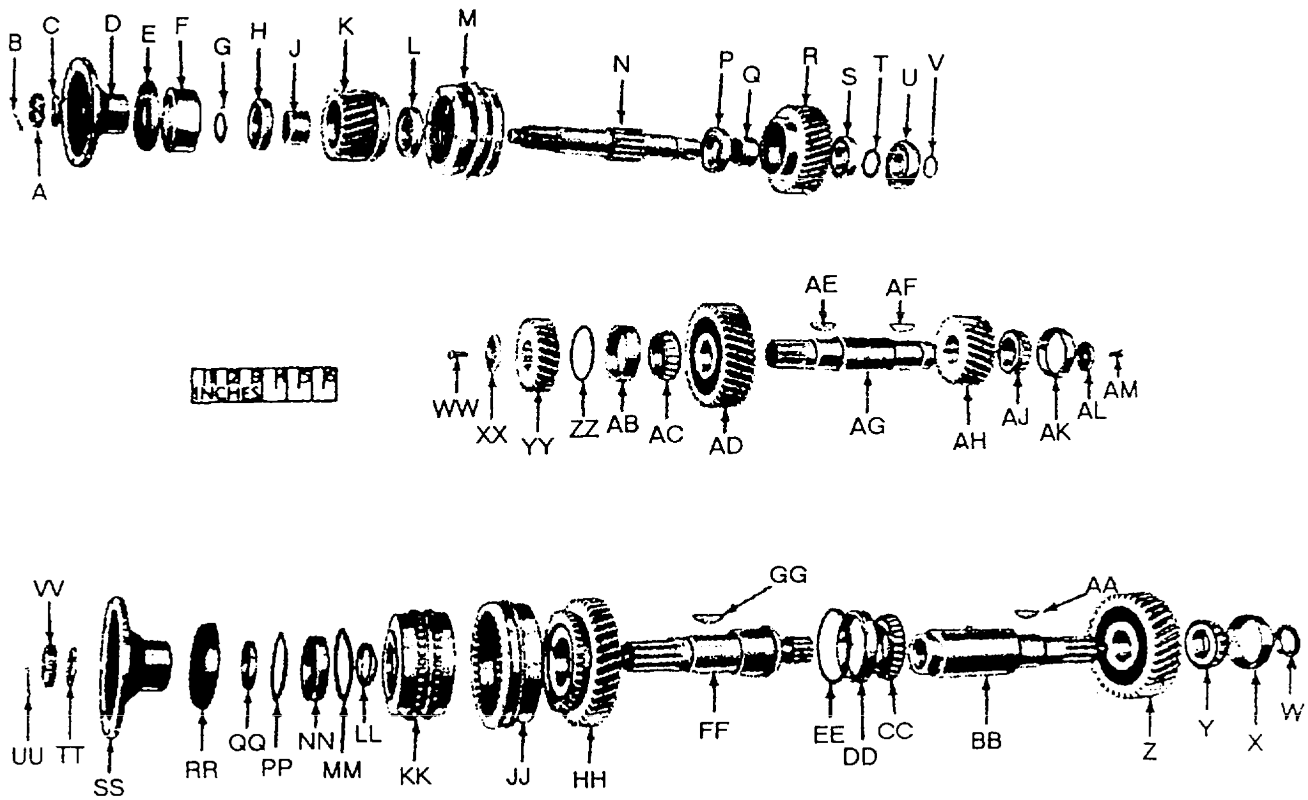


Figure 11-11.—Transfer case high low gearshift shaft, locking setscrew and locking wire.



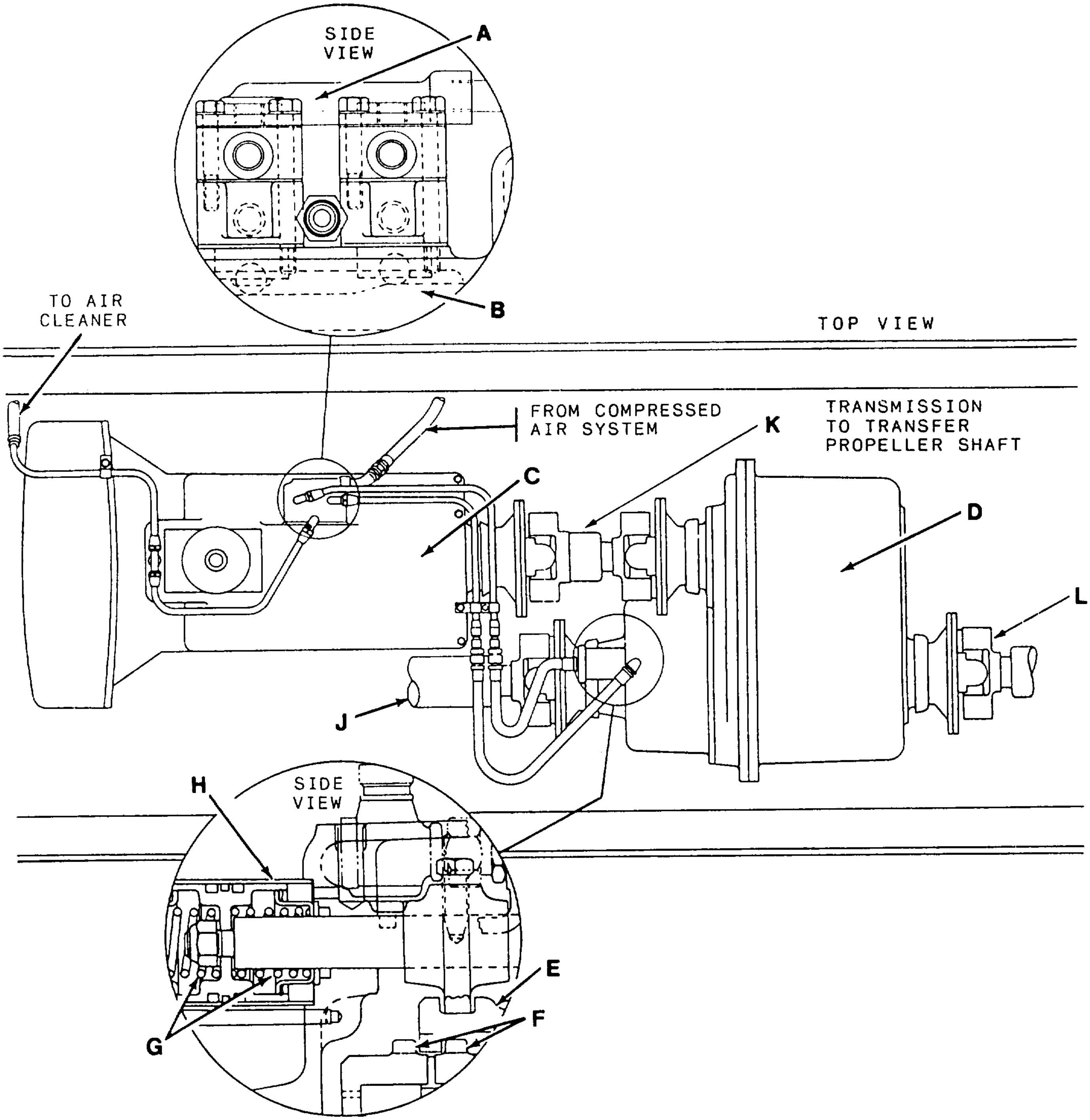
A. Fork, shifter, high- and low-speed
B. Shaft, shifter, input shaft gear
C. Seal, oil, gear shifter shaft
D. Ball, poppet
E. Plunger, poppet ball
F. Spring, compression, poppet ball
G. Washer, lock internal teeth
H. Screw, plunger
J. Screw, set sq-hd

Figure 11-12.—High low shifter shaft and fork-exploded view-legend.



A. Nut, sltd
B. Pin, cotter
C. Washer, plain
D. Flange, companion, input shaft
E. Slinger, dust, flange
F. Bearing, ball, input shaft, front
G. Spacer, input shaft front bearing
H. Bearing, ball, input shaft low-speed gear, front
J. Spacer, input shaft low-speed gear
K. Gear, low-speed, input shaft
L. Bearing, ball, input shaft low-speed gear, rear
M. Synchronizer, gear
N. Shaft, input
P. Bearing, ball, input shaft high-speed gear, front
Q. Spacer, input shaft high-speed gear front bearing
R. Gear, high-speed, input shaft
S. Bearing, ball, input shaft high-speed gear, rear
T. Spacer, input shaft rear bearing
U. Bearing, ball, input shaft, rear
V. Ring, snap, input shaft, rear bearing
W. Washer, spacing, rear output shaft rear bearing
X. Cup, rear output shaft rear bearing
FF. Shaft, output, front
GG. Key, Woodruff
HH. Gear, driven, front output shaft
JJ. Collar, reverse shift
KK. Sprag unit
LL. Washer, spacing, front output shaft bearing, inner
MM. Ring, snap, front output shaft bearing, rear
NN. Bearing, ball, front output shaft
PP. Ring, snap, front output shaft bearing, front
QQ. Washer, spacing, bearing, outer
RR. Slinger, dust, flange
SS. Flange, companion, front output
TT. Washer, plain
UU. Pin, cotter
VV. Nut, sltd
WW. Screw, cap
XX. Washer, retaining
YY. Gear, drive, intermediate shaft
ZZ. Ring, snap, intermediate shaft front, bearing
AB. Cup, intermediate shaft front bearing
AC. Cone, intermediate shaft front bearing
AD. Gear, low-speed, intermediate, shaft
AE. Key, Woodruff
AF. Key, Woodruff

Figure 11-13.—Transfer shafts, bearing, and gears–exploded view–legend.



A.	Air cylinder control valve	G.	Balanced spring loading
B.	Reverse shift rail	H.	Shift air cylinder assembly
C.	Transmission	J.	Front output shaft
D.	Transfer	K.	Propeller shaft
E.	Reverse shift collar	L.	Rear output shaft
F.	Sprag unit assembly		

Figure 11-14.—Front axle engagement air control diagram–legend.

TROUBLESHOOTING THE POWER TAKEOFF

Power takeoffs are attachments in the power train for power to drive auxiliary accessories. They are attached to the transmission, auxiliary transmission, or transfer case. A common type of power takeoff is the single-gear, single-speed type. This unit is bolted to art opening provided in the side of the transmission case, as shown in figure 11-15. The sliding gear of the power takeoff will then mesh with the transmission countershaft gear. The operator can move a shifter shaft control lever to slide the gear in and out of mesh with the countershaft gear. The spring-loaded ball holds the shifter shaft in position.

On some vehicles, you will find power takeoff units with gear arrangements that will give two speeds forward and one in reverse. Several forward speeds and reverse gear arrangements are usually provided in power takeoff units that operate winches and hoists. Their operation is about the same as the single-speed units.

The troubleshooting and repair procedures for the power takeoff are similar to those for the transfer case and are listed in table 11-3.

TROUBLESHOOTING THE PROPELLER SHAFT ASSEMBLY

The propeller shaft, or drive shaft, assembly consists of the shaft, a splined slip joint, and one or more universal joints. This assembly provides a flexible connection through which power is transmitted from the transmission to the differential. The propeller shaft is almost always tubular.

A splined slip joint is provided at one end of the propeller shaft to take care of end play. The driving axle, being attached to the springs, is free to move up and down while the transmission is attached to the frame and cannot move. Any upward or downward movement of the axle, as the springs are flexed, shortens or lengthens the distance between the axle assembly and the transmission. To compensate for this changing distance, the slip joint is provided at one end of the propeller shaft.

The usual type of splined slip joint consists of a splined stub shaft welded to the propeller shaft that fits into a splined sleeve. A cross-sectional view of the splined slip joint and universal joint is shown in figure 11-16.

A universal joint is a connection between two shafts that permits one to drive the other at an angle. Passenger

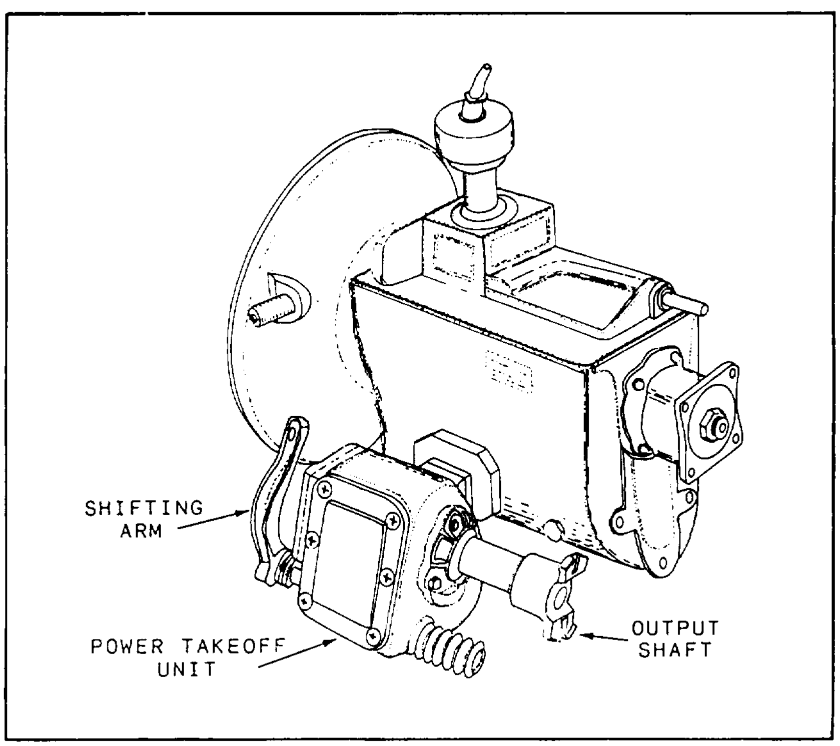


Figure 11-15.—Power takeoff mounted on a vehicle transmission.

Table 11-3.—troubleshooting the Power Takeoff

Troubleshooting the Power Takeoff		
Malfunction	**Probable Causes**	**Corrective Action**
1. Noisy power takeoff.	a. Stripped gears.	a. Replace defective gears.
	b. Worn bearings.	b. Replace defective bearings.
	c. Worn shaft splines.	c. Replace shafts.
2. Slipping out of gear.	a. Gears partially engaged.	a. Correctly adjust shift linkage.
	b. Weakened poppet springs.	b. Replace springs.

vehicles and trucks usually have universal joints at both ends of the propeller shaft.

Universal joints are double-hinged with the pins of the hinges set at right angles. They are made in many different designs, but they all work on the same principle.

Normally, universal joints do not require any maintenance other than lubrication. Some universal joints (U-joints) have grease fittings and should be lubricated when the vehicle has a preventive maintenance inspection. Others may require disassembly and lubrication periodically. When lubricating U-joints that have grease fittings, use a low-pressure grease gun to avoid damaging seals.

TROUBLESHOOTING THE DIFFERENTIAL

The purpose of the differential is easy to understand when you compare a vehicle to a company marching in mass formation. When the company makes a turn, the members in the inside tile must take short steps, almost marking time, while members in the outside file must take long steps and walk a greater distance to make the turn. When a motor vehicle turns a corner, the wheels

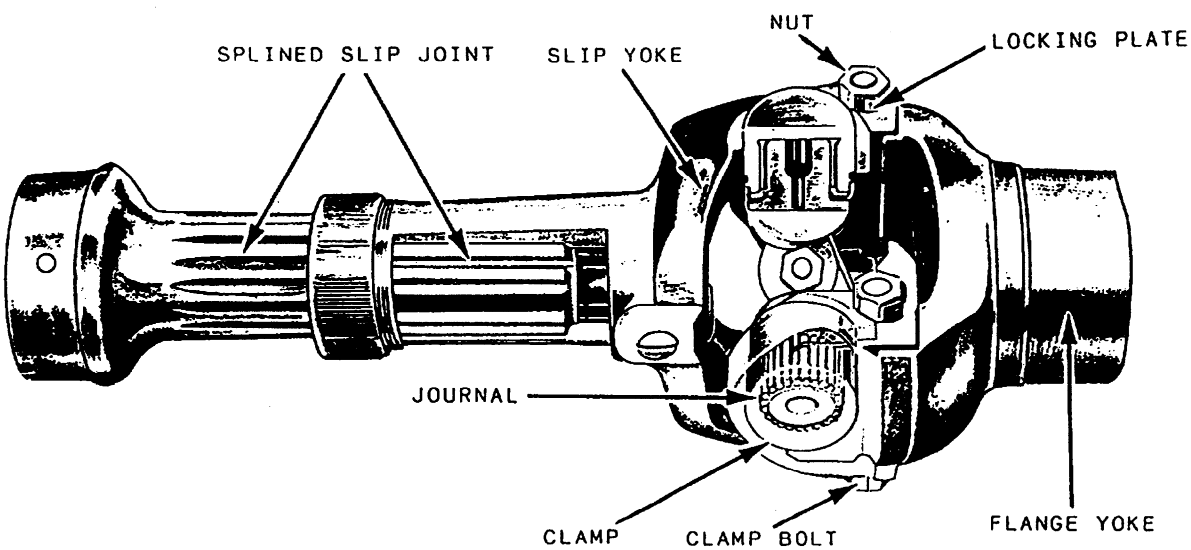


Figure 11-16.—An example of a splined slip joint and a common type of universal joint.

on the outside of the turn must rotate faster and travel a greater distance than the wheels on the inside. This causes no difficulty for the front wheels on the usual passenger car because each wheel rotates independently. However, for the rear wheels to be driven at different speeds, the differential is needed. It connects the individual axle shaft for each wheel to the bevel drive gear; therefore, each shaft can turn at a different speed and still be driven as a single unit. Refer to the illustration in figure 11-17 as you study the following discussion on differential operation.

The bevel drive pinion, connected to the propeller shaft, rotates the bevel drive gear and the differential case which is attached to it. Within the case, the differential pinions are free to turn on individual pivots called trunnions. Power is transmitted to the axle shafts through the differential pinions and the side gears. The axle shafts are splined to the side gears and keyed or bolted to the wheels.

When the resistance is equal on each rear wheel, the differential pinions, side gears, and axle shafts all rotate as ONE UNIT with the drive gear. In this case, there is no relative motion between the pinions and the side gears in the differential case; that is, the pinions do not turn on the trunnions, and their teeth will not move over the teeth of the side gears.

When the vehicle turns a corner, one wheel must turn faster than the other. The side gear driving the outside wheel will run faster than the side gear connected to the axle shaft of the inside wheel. To compensate for this difference in speed and to remain in mesh with the two side gears, the differential pinions must then turn on the trunnions. The average speed of the two side gears, axle shafts, or wheels is always equal to the speed of the bevel drive gear.

To overcome the situation where one spinning wheel might be undesirable, some trucks are provided with a DIFFERENTIAL LOCK. This is a simple dog clutch, controlled manual] y or automatically, which locks one axle shaft to the differential case and bevel drive gear. Although this device forms a rigid connection between the two axle shafts and makes both wheels rotate at the same speed, it is used very little. Too often, the driver forgets to disengage the lock after using it. There are, however, automatic devices for doing almost the same thing. One of these, which is used rather extensively today, is the high-traction differential. It consists of a set of differential pinions and side gears

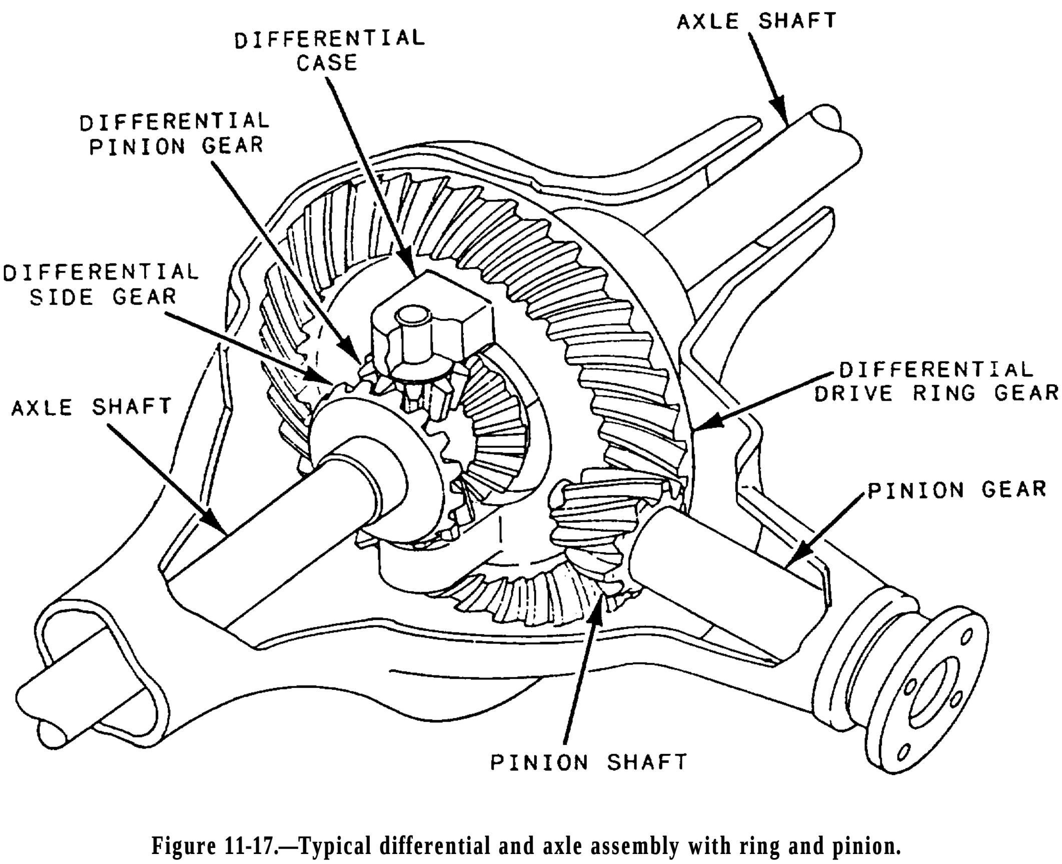


Figure 11-17.—Typical differential and axle assembly with ring and pinion.

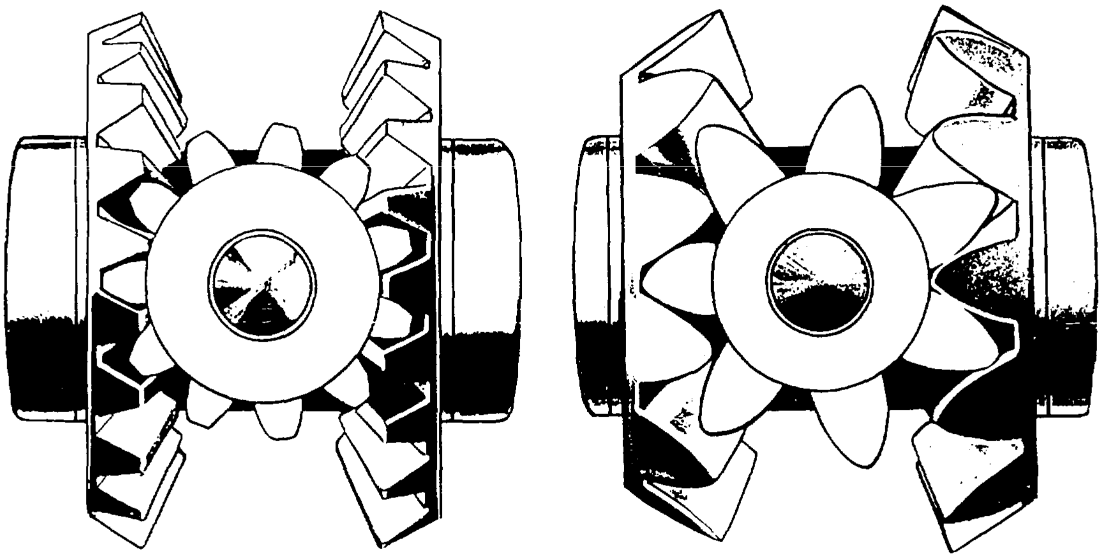


Figure 11-18.—Comparison of high-traction differential gears and standard differential gears.

that have fewer teeth and a different tooth form from the conventional gears. Figure 11-18 shows a comparison between these and standard gears. These differential pinions and side gears depend on a variable radius from the center of the differential pinion to the point where it comes in contact with the side gear teeth, which is, in effect, a variable lever arm. As long as there is relative motion between the pinions and side gears, the torque is unevenly divided between the two driving shafts and wheels; whereas, with the usual differential, the torque is evenly divided at all times. With the high-traction differential, the torque becomes greater on one wheel and less on the other as the pinions move around until both wheels start to rotate at the same speed. When this occurs, the relative motion between the pinion and side gears stops, and the torque on each wheel is again equal. This device assists considerably in starting the vehicle or keeping it rolling in cases where one wheel encounters a slippery spot and loses traction while the other wheel is on a firm spot and has traction. It will not work, however, when one wheel loses traction completely. In this respect, it is inferior to the differential lock.

With the non-spin differential (fig. 11- 19), one wheel cannot spin because of loss of tractive effort and thereby deprive the other wheel of driving effort; for

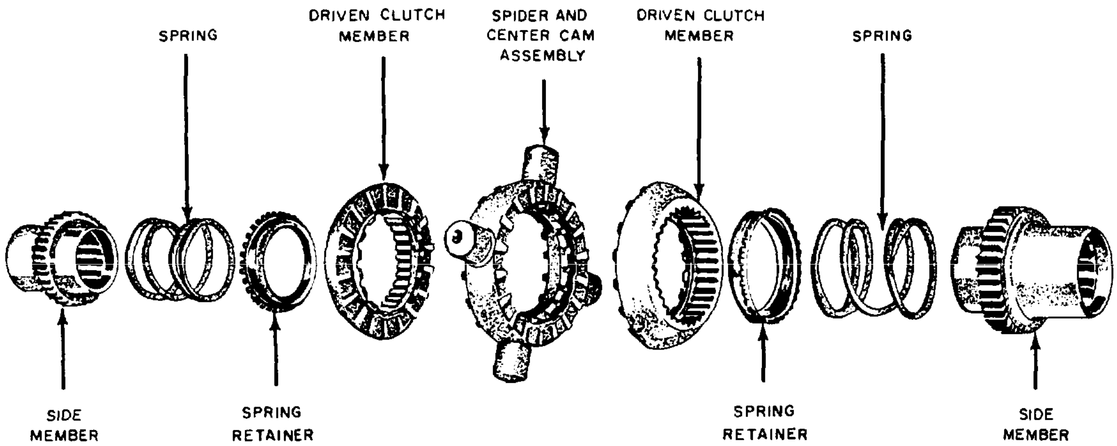


Figure 11-19.—No spin differential-exploded view.

example, one wheel is on ice and the other wheel is on dry pavement. The wheel on ice is assumed to have no traction. However, the wheel on dry pavement will pull to the limit of its tractional resistance at the pavement. The wheel on ice cannot spin because wheel speed is governed by the speed of the wheel applying tractive effort.

The no-spin differential does not contain pinion gears and side gears as the conventional differential does. Instead, it consists essentially of a spider attached to the differential drive ring gear through four trunnions, plus two-driven clutch members with side teeth that are indexed by spring pressure with side teeth in the spider. Two side members are splined to the wheel axles and, in turn, are splined into the driven clutch members.

The first hint of existing trouble in a differential is generally an unusual noise in the rear axle housing. However, to diagnose the trouble properly, you must determine the source of the noise and under what operating conditions the noise is most pronounced. Defective universal joints, rough rear wheel bearings, or tire noises may be improperly diagnosed by the inexperienced mechanic as differential trouble. Some clue may be gained as to the cause of trouble by your noting whether the noise is a growl, hum, or knock; whether it is hard when the car is operating on a straight road, or on turns only; and whether the noise is most noticeable when the engine is driving the vehicle or when it is coasting with the vehicle driving the engine.

A humming noise in the differential generally means the ring gear or pinion needs an adjustment. An improperly adjusted ring gear or pinion prevents normal tooth contact between the gears and, therefore, produces rapid gear tooth wear. If the trouble is not corrected immediately, the humming noise will gradually take on growling characteristics, and the ring gear and pinion will probably have to be replaced.

It is easy to mistake tire noise for differential noise. Tire noise will vary according to the type of pavement the vehicle is being driven on, and differential noise will not. To confirm a doubt as to whether the noise is caused by tire or differential, drive the vehicle over various types of pavement.

If a noise is present in the differential only when the vehicle is rounding a cornr, the trouble is likely to be in the differential case assembly.

AXLES, WHEELS, AND TRACKS

A live axle may support part of the weight of a vehicle and also drive the wheels connected to it. A dead axle carries part of the weight of a vehicle but does not drive the wheels. The wheels rotate on the ends of the dead axle.

Usually, the front axle of a passenger car is a dead axle, and the rear axle is a live axle. In four-wheel drive vehicles, both front and rear axles are live axles, and in six-wheel drive vehicles, all three axles are live axles. The third axle, part of a BOGIE DRIVE, is joined to the rearmost axle by a trunnion axle, as shown in figure 11-20. The trunnion axle is attached rigidly to the frame. Its purpose is to help in distributing the load on the rear of the vehicle to the two live axles which it connects.

There are three types of live axles used in automotive and construction equipment. The y are as follows: semifloating, three-quarter floating, and full-floating.

Semifloating Axles

The semifloating axle (fig. 11-21) used on most passenger cars and light trucks has its differential case independently supported. The differential carrier relieves the axle shafts from the weight of the differential assembly and the stresses caused by its operation. For this reason, the inner ends of the axle shafts are said to be floated. The wheels are keyed or bolted to outer ends of axle shafts, and the outer bearings are between the shafts and the housing. Therefore, the rude shafts, must take the stresses caused by turning or skidding of the wheels. The axle shaft in a semifloating live axle can be removed after the wheel and brake drum have been removed.

Three-Quarter Floating Axles

The axle shafts in a three-quarter floating axle (fig. 11-22) may be removed with the wheels that are keyed to the tapered outer ends of the shaft. The inner ends of the shafts are carried as in a semifloating axle. The axle housing, instead of the shafts, carries the weight of the vehicle because the wheels are supported by bearings on the outer ends of the housing. However, axle shafts must take the stresses caused by the turning, or skidding of the wheels. Three-quarter floating axles are used in some trucks but in very few passenger cars.

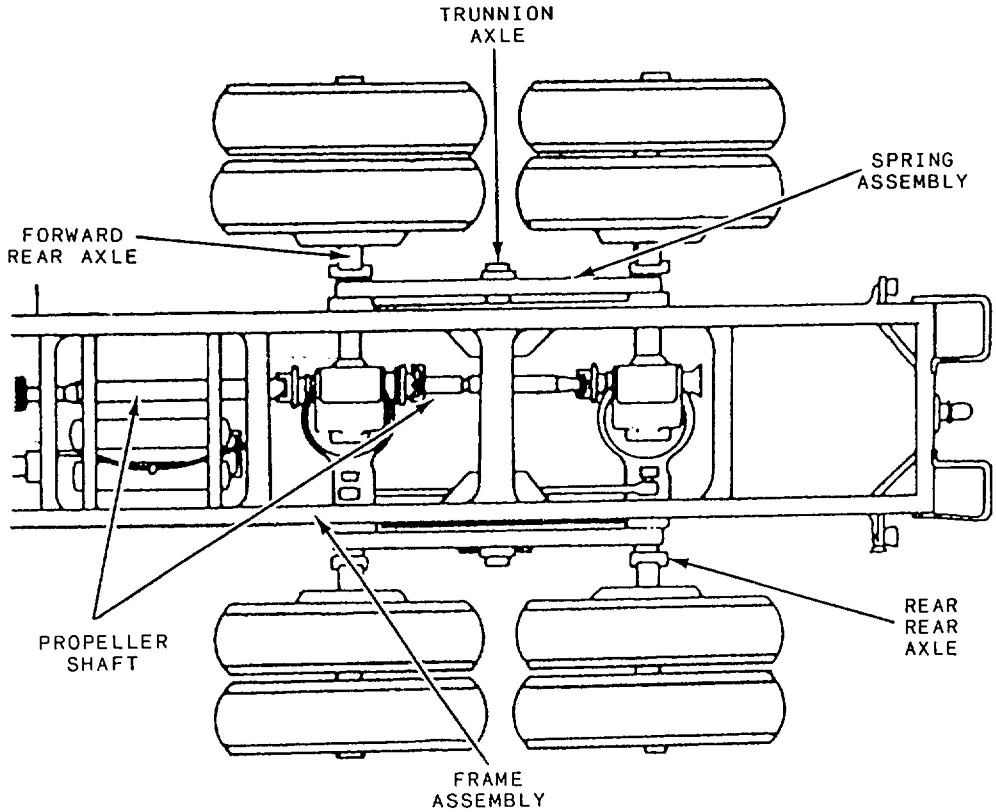


Figure 11-20.—Typical tandem axle system.

Full-Floating Axles

The full-floating axle is used in most heavy trucks. (See fig. 11-23.) These axle shafts may be removed and replaced without removing the wheels or disturbing the differential. Each wheel is carried on the end of the axle tube on two ball bearings or roller bearings, and the axle shafts are bolted to the wheel hub. The wheels are driven through a flange on the ends of the axle shaft which is bolted to the outside of the wheel hub. The bolted connection between the axle and wheel does not make

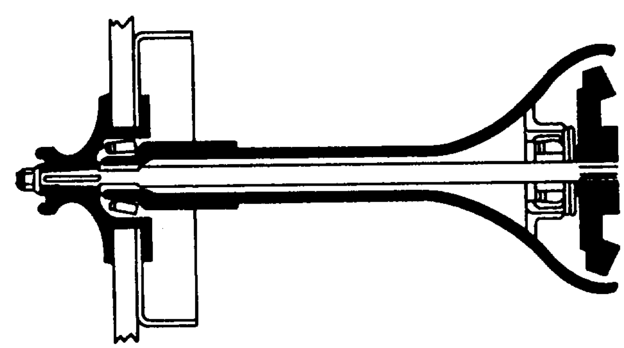


Figure 11-22.—Three-quarter floating rear axle.

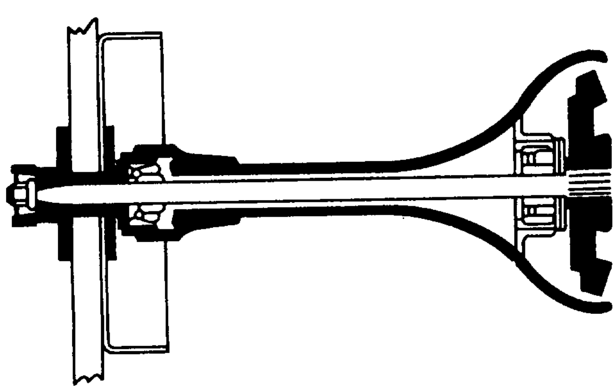


Figure 11-21.—Semifloating rear axle.

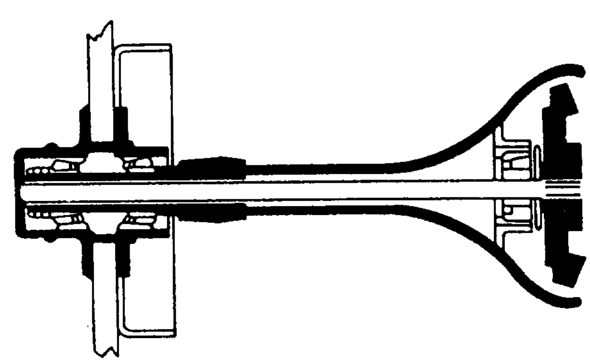


Figure 11-23.—Full-floating rear axle.

this assembly a true full-floating axle, but nevertheless, it is called a floating axle. A true full-floating axle transmits only turning effort or torque.

Driving Wheels

Wheels attached to live axles are the driving wheels. The number of wheels and number of driving wheels is sometimes used to identify equipment. You, as a mechanic, may identify a truck by the gasoline or diesel engine that provides the power. Then again, you may refer to it as a bogie drive.

Wheels attached to the outside of the driving wheels make up DUAL WHEELS. Dual wheels give additional traction to the driving wheels and distribute the weight of the vehicle over a greater area of road surface. They are considered as single wheels in describing vehicles; for example, a 4 x 2 could be a passenger car or a truck having four wheels with two of them driving. A 4 x 4 indicates a vehicle having four wheels with all four driving. In some cases, these vehicles will have dual wheels in the rear. You would describe such a vehicle as a 4 x 4 with dual wheels.

A 6 x 4 truck, although having dual wheels in the rear, is identified by six wheels, four of them driving. Actually, the truck has ten wheels but the four wheels attached to the driving wheels could be removed without changing the identity of the truck. If the front wheels of this truck were driven by a live axle, it would be called a 6 x 6.

The tracks on tracklaying vehicles are driven in much the same manner as wheels on wheeled vehicles. Sprockets instead of wheels are driven by live axles to move the tracks on the rollers. These vehicles are identified as either full-track, half-track or vehicles that can be converted.

Full-Track Vehicles

Full-track vehicles are entirely supported, driven, and steered by two tracks that replace all wheels.

SERVICE AND MAINTENANCE

There are very few adjustments to be made in power trains during normal operation. Most of your duties concerned with power trains will be limited to preventive maintenance. You will be working with the disassembly, repair, and reassembly of transmissions, rear axles, and propeller shaft assemblies when they break down. You will also inspect these units for indications of major repairs needed. Major repairs can be reduced by proper lubrication and periodic inspection of gear cases, propeller shafts, and wheel bearings.

Proper lubrication depends upon the use of the right kind of lubricant which must be put in the right places in the amount specified by the LUBRICATION CHARTS. The charts, provided with the vehicle, will also show what units in the power train will require lubrication, and where they are located. These units are similar to the ones described and illustrated in this chapter.

In checking the level of the lubricant in GEAR CASES and before you add oil, keep these two important points in mind: first, always carefully wipe the dirt away from around the inspection plugs and then use the proper size wrench to remove and tighten them. A wrench too large will round the corners and prevent proper tightening of the plug. For the same reason, never use a pipe wrench or a pair of pliers for removing plugs. Second, be sure the level of the lubricant is right-usually just below or on a level with the bottom of the inspection hole. Before checking the level, allow the vehicle to stand for a while on a level surface so the oil can cool and find its own level. Oil heated and churned by revolving gears expands and forms bubbles. Although too little oil in the gearboxes is responsible for many failures of the power train, do not add too much gear lubricant. Too much oil results in extra maintenance.

Excessive oil or grease can find its way past the oil seals or gear cases. It maybe forced out of a transmission into the clutch housing and result in a slipping clutch; or it may get by the rear wheel bearings from the differential housing to cause brakes to slip or grab. In either case, you will have extra work to do. Always clean differential and live axle housing vents to prevent pressure buildup (caused by heat), which can result in leaking seals.

UNIVERSAL JOINTS and SLIP JOINTS at the ends of propeller shafts are to be lubricated if fittings are provided. The same holds true for WHEEL BEARINGS. Some of these joints and bearings are packed with grease when assembled; others have grease fittings or small plugs with screwdriver slots that can be removed for inserting grease fittings. Do not remove these plugs until you consult the manual for instructions.

Some passenger cars and trucks have a leather boot or shoe covering the universal and slip joint. The boot prevents grease from being thrown from the joint and it also keeps dirt from mixing with the grease. A mixture of dirt and grease forms an abrasive that will wear parts in a hurry. Never use so much grease on these joints that the grease will be forced out of the boot. The extra grease will be lost and the added weight of the grease will tend to throw the propeller shaft out of balance.

When you are to give a vehicle a thorough inspection, inspect the power trains for loose gear housings and joints. Look for bent propeller shafts that are responsible for vibrations, and examine the gear housings and joints for missing screws and bolts. Check to see that the U-bolts fastening the springs to the rear axle housing are tight. A loose spring hanger can throw the rear axle assembly out of line and place additional strain on the propeller shaft and final drive. When making these inspections, always tighten the lugs that fasten wheels to live axles.

After tightening gear housings, loose connections, and joints, and finding that no repairs are required, road test the vehicle to see if the various units in the power train are working properly. Shift the gears into all operating speeds and listen for noisy or grinding gears.

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